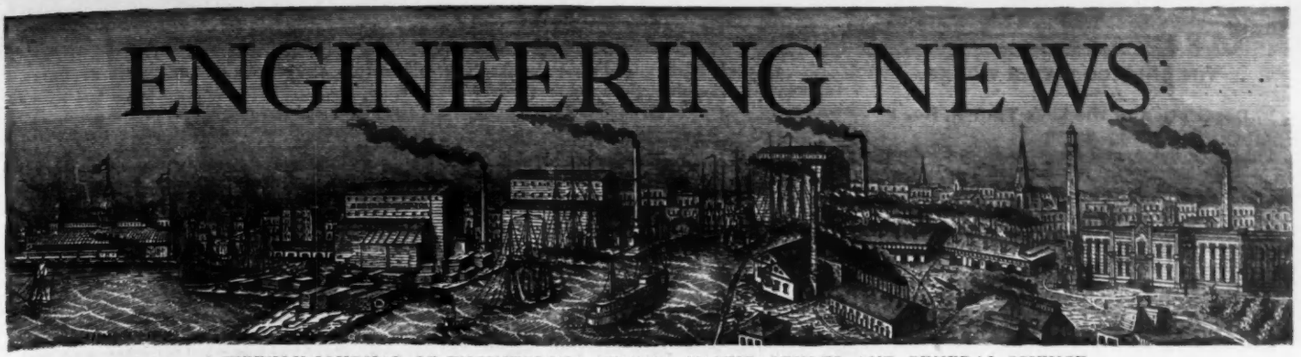
ENGINEERING NEWS:



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Engineering Notes.

A transfer of the charter of the Montreal, Ottawa and Western Railway has been completed, and Mr. Legge, the Chief Engineer, and Mr. Macdonald, the contractor, have signed a new contract with the Provincial Government of Ontario. The price is fixed at $28,000 per mile, including steel rails, iron bridges, &c. The original contract with the company was for $33,000 per mile. The saving arises from the cheapness of labor and the fall in the cost of materials, and also from the fact that the contractor will be paid in cash.

The total production of rails of all kinds in the United States in 1874, was 729,413 tons, as compared with 890,077 tons in 1873. It appears that 19 states made rails in 1874, against 18 in 1873, Kansas having entered the list in May, 1874. The number of rail mills in the United States in 1874 was 91, of which 57 made heavy rails mainly and 34 made only light street rails; of the 91 mills, 22 made no rails in 1874. The capacity of all the 91 mills combined in 1874, was double their actual production. Almost one half the total production of rails in the United States in 1874, consisted of old rails re-rolled.

The proportion of the working expenses to the traffic receipts of the Union Pacific Railroad declined in the year ending June 30, 1875, to 41.56 per cent as compared with 49.67 per cent in 1873–4. The mountain divisions of the line are being supplied with steel rails as fast as they can be obtained; 1015 tons of steel rails were laid down upon the system in 1874–5. The establishment of a rolling mill at Laramie has effected a great saving in the cost of re-rolling rails. As regards sleepers, some considerable improvements have been realized; on the western part of the line large quantities of red pine ties are being used, this wood holding a spike almost equally with oak. On the eastern part of the line, oak ties are largely in use. The red pine ties cost about 50 cents each, while the oak ties cost 80 cents each. The production of coal effected at the company's mines last year was 185,681 tons, the average being $1.99 per ton.

The total area of Washington territory is 44,796,160 acres, of which 11,700,952 acres have been surveyed. During the two years ending with June 30, 1875, there have been surveyed 3,213,141 acres of public lands and 264,144 acres of Indian reservations.

The production of Bessemer steel rails in the United States in 1867 was 3000 tons. In 1869, it had been carried to 12,000 tons; and in 1872 to 110,000 tons. In 1873, the production further expanded to 157,900 tons, and in 1874, to 176,500 tons. At the close of 1874 there were eight Bessemer mills producing rails in the United States; by the close of 1875, the number of these mills is expected to be carried to eleven. In 1867, the average price of steel rails in the United States was $160 per ton; this year it has sunk to $75 per ton.

The Connecticut Central Railroad extending from Hartford, Conn. to Springfield, Mass., work on which was commenced early in the Spring of 1875, is nearly completed, and trains are expected to be running by January 1st 1876.

This road forms a connection at Hartford with the Connecticut Valley R. R. which runs to tidewater at Saybrook, and at Springfield with the Boston and Albany. Conn. River, and Springfield and Athol railroads, thereby forming, with these roads, an all rail through route from tidewater at Saybrook to all parts of central and northern New England, and also a competing line with the New York, New Haven, and Hartford road.

The road from Hartford to the Massachusetts state line, is called the Conn. Central, and from that point to Springfield, the Springfield and Longmeadow R. R. Both of these roads have been leased to the Connecticut Valley R. R. at the rate of 4 per cent per annum on its capital stock.

Starting from Hartford the Conn. Central crosses the Connecticut River over the Hartford, Providence and Fishkill R. R. bridge, and passes through the manufacturing towns of East Windsor, Broadbrook, Scitico, Enfield and Longmeadow, and gives to this section of the State new railroad facilities. From Broadbrook a branch connecting with Rockville is to be built.

The road will do a large freight business, especially in coal and articles that enter into manufacturing, and in the Summer a good passenger traffic. As there are no heavy cuttings, and but a few bridges, the road has been one of easy construction.

It was built by Willis Phelps of Springfield, Mass., the contract price being $25,000 per mile, exclusive of the rails. It is laid with steel rails, and fish-plate joints.

Mr. I. W. Clapp was the Chief Engineer.

Work on the Mississippi Jetties.

Captain James B. Eads, in a letter to Mr. J. S. Walsh, president of the South Pass Jetty Company, of St Louis, thus sums up the work done at the mouth of the Mississippi River: —

"From what I have written you will see that the river discharge is now largely controlled on one side by the east jetty, while a large portion of the water escapes over the mattresses of the west jetty, which are not yet high enough to control it. The effect of closing the opening between the west jetty and the west bank has, however, tended to throw more of the discharge down by the east jetty, and for a distance of three thousand feet (seven thousand from the land's end, or east point) the result has been a decided deepening of the channel, varying from one foot to four or five feet, from the upper end of the west jetty seawards. A decided deepening between the ends of the jetties out at sea has also occurred, caused, doubtless, by the tidal action of the sea, which is controlled to some extent by the guide piles, although the matresses at the extreme end are not yet built up sufficiently to justify anticipating any marked effect of the tide. Our piling was driven in twenty-six feet of water at the end of the east jetty, and we have now thirty-three feet for some distance landward. A decided deepening extends five hundred feet in this direction. The bar is, therefore, being attacked on the one side by the river and on the other by the sea, and, as a result, the base of it, in the line of the channel, is materially shortened already by their action. Not less than seven hundred thousand cubic yards of earth have been removed by the effect of the jetties thus far, and we have everything to encourage us to believe that success is certain," —*N. Y. Post.*

Notes.

Twenty-one Illinois railroads are in the hands of receivers.

444 vessels, representing 127,963 tons are laid up for the winter in Chicago Harbor.

The State of Massachusetts has expended 12,000,000 dollars in the construction of the Hoosac Tunnel.

There are 72 locks between Buffalo and Albany, on the Erie Canal. The length of the canal is 345 miles.

The largest Locomotive in this country is now running on the Pennsylvania Central R. R. It has 15 drivers and weighs 75 tons.

It is not likely that any further appropriation will be made for the improvement of the harbor at South Chicago for several years to come.

The cars of the Pueblo and Arkansas Valley railroad, run into Rocky Ford to-day, Dec. 30th, 1875. Rocky Ford is fifty miles from Pueblo. The bridges are finished up to the river crossing thirty miles east of Pueblo.

Mr. A. A. Robinson, Chief Engineer of the Pueblo and Arkansas Valley railroad, announces that the supply of iron is now ample, and that should no unforeseen accident prevent, the tracklayers will be at the crossing of the Arkansas, January 20th, and at Pueblo, Col. February 20th. The track is now west of Rocky Ford.

The railway system of Great Britain has 14,600 miles of railway, representing a capital of nearly $3,000,000,000 and an annual revenue of $300,000,000, and gives employment in one capacity or other to 275,000 men, of whom 107,000 are employed in working the traffic; 82,000 in the locomotive department; 60,000 in the engineering or permanent way staff, and 16,000 in various other occupations.

A writer in the Topeka *Commonwealth* makes the following remarks with reference to Pueblo and her prospects:

Pueblo, which is the location of an old Mexican or Spanish town, is situated on both branches of the Arkansas river forty miles east of the point where the river emerges from the mountains. At the present time the Atchison, Topeka and Santa Fe railroad is fast approaching Pueblo, and will be in operation early the coming spring. Pueblo is now connected by the Denver and Rio Grande railroad with Colorado Springs and Denver on the north, with Canon City on the west, and will soon have direct connection with Trinidad on the south and the San Luis valley and the San Juan mining region to the southwest. This line of road is now being rapidly constructed from Pueblo to the Cucharas, which is a point east of the Sangre de Cristo river, and not more than one hundred miles distant from Del Norte, with one branch running south along the base of the mountains in the direction of New Mexico and western Texas, and another running through the Sangre de Cristo Pass in the heart of the San Juan mining country. This road will not only open up an immense domain to settlement and civilization, but it will furnish to its main eastern connection, the Atchison, Topeka and Santa Fe railroad, an almost unlimited business. Should the last named road stop at Pueblo, and aid in an extension of a system of narrow gauge roads into the Rocky Mountain regions, Denver will have a powerful rival in Pueblo, and it will not be long before the balance of the population in Colorado will be south of Colorado Springs, and the main outlet to the east via the Arkansas valley.

There are now three lines of approach from the east to the San Juan country, and I will name them in the order of their excellence of lines of travel: Frst, via the Sangre de Cristo Pass and Fort Garland to Del Norte. Second, via Canon City, up the Arkansas river, to the Poncho Pass, and thence down the San Luis valley to Del Norte. And third, through the Rita Pass west of Colorado Springs, touching the route through Poncho Pass about eeventy-five miles north-west of Canon City on the upper Arkansas.

When the Denver and Rio Grande road is completed to Cucharas, which is forty miles south of Pueblo, the distance from the railroad to Del Norte will be reduced to about one hundred miles. I will say in passing, that the road is good, built over the Pass and through the San Luis valley, not only for heavy freight but for rapid stage travel. The completion of the railroad to Cucharas will make this line the main avenue of travel for those going in and out of the mines next season.

THE CHICAGO WATER WORKS.

Description of the Lake Tunnel, No. 1

From the Eighth Annual Report of E. S. Chesbrough, City Engineer, for the year ending March 31, 1869.

[CONTINUED.]

CHAMBERS.

With trifling exceptions, this work was prosecuted day and night by means of two sets of miners and one of masons, working eight hours each in every twenty-four, for six days in the week, till the 16th of October, when a point about 750 feet from the centre of the shaft was reached. Here it was determined to make two temporary chambers, one on each side of the tunnel, with which they were to be connected by small and short openings. It took about one week to construct these chambers and connections, all of which were supported by timbers and planks. In the tunnel and at the connection between the chambers a turn-table was placed. This arrangement permitted not only the passage of cars by each other, but also the making up of trains, which soon became an absolute necessity for the economical and rapid execution of the work. By means of such chambers, it was practicable to carry on the work a mile or more out under the lake as fast as could be done near the bottom of the land shaft; in fact, the progress upwards of a mile out was really greater than it was near the shore, owing to the greater skill and experience acquired on the way. A gap of about six feet in the masonry of the tunnel was left at the connection between these, the first chambers, to be built in after the completion of the rest of the work. After two or three weeks, several cracks, entirely around the tunnel, were discovered in the brick work within a distance of about 12 feet, on each side of the turn-table There were various conjectures as to the cause of these cracks, for up to this time repeated careful observations had shown no indications whatever of any movement in the masonry after the keying of the upper arch. Occasionally, in soft ground, the sides of the lower arch had been pressed in an inch or two before the upper arch was built, but no transverse crack was ever discovered except those near the chambers. The conclusion was that they were probably caused by the yielding of the earth in the pit of the turn-table; yet, no settlement in the masonry was observed.

The second set of chambers was made one thousand feet beyond the first, and the character of the work, as well as the mode of carrying it on, continued the same, except that the use of mules was substituted for men in the transportation of earth and materials for the masonry. Stout abutments were built on each side of this turn-table to prevent the cracking of the brick work, observed on each side of the first, but just the same number and character of cracks occurred, notwithstanding. It then became evident that these cracks were owing to a tendency in the clay to move, or "creep," as it is sometimes expressed, towards any cavity made in it. The gap left at the connection between the chambers being only temporarily supported with wood, could not wholly prevent this creeping movement. It was, therefore, determined afterwards to continue the brick work over and around the next turn-table, and to brick around the connections between the chambers, groining carefully their intersections with the tunnel. After this method of constructing the chamber connections was carried out, all trouble from cracks ceased. In this manner, placing the sets of chambers about a thousand feet apart, the work was continued to about a mile and a half from the land shaft.

The character of the work continued throughout very much the same. The greatest progress made during any one week was 93 feet. Only once was a boulder so large as to require blasting met with. There was a little nervousness as to the effect of a blast under the lake, but it caused no serious disturbance either of the ground or the masonry.

VENTILATION.

The ventilation of the tunnel was effected by means of tin pipes, through which the foul air was drawn out and fresh air consequently drawn in through the main opening. At first a six inch pipe was used, and this was connected with the furnace of the hoisting engine. Later it became necessary to provide an engine and fan expressly for this purpose and to put in larger pipes. Eight inch ones were introduced. It was difficult to keep the joints of the pipes, which were only of ordinary tin, very tight, especially near the chambers, where the mules struck them with their heads in turning. Still, they answered a very good purpose, and the air, a mile and a half out, was about as good as it was much nearer to the land shaft. Ordinarily there was so much smoke from the miner's lamps and vapor from the heat of the workmen as to make it impossible to see distinctly enough to run the lines and levels required to keep the tunnel in the right direction. On Sunday nights, however, and on other holidays, the air became so clear as to cause sperm candles to burn with a beautiful silver brightness, visible sometimes two thousand feet.

ALIGNMENT,

To determine the position of the lake shaft and the line of the tunnel much pains was taken to establish

an accurate base on the shore for purposes of triangulation. Owing to the buildings in the way, this was no easy task. For the alignments of the tunnel an astronomical transit of four inch aperture, by Pike of New York, was mounted on a tower built for the purpose, 266 feet westward of the land shaft, and sometimes used in the chamber below already described. To aid in placing the land shaft beyond all doubt in the line of the tunnel, a 6 inch tube was sunk 280 feet eastward of the land shaft, after the masonary had been carried beyond that point. By plumbing up through this tube, a "range" of great accuracy for such a purpose was obtained. The astronomical transit could only be used on the tower above or in the chamber below. As soon as the work had been carried so far that the sperm candles used in the alignment could not be seen at "the face" of the work, the centre line was produced from point to point by means of a goniometer with two telescopes, which, when in perfect adjustment, could be made to "reverse" on the same point, which was thus proved to be in a straight line with the instrument and the "back sight." All of these operations, as well as those necessary for lines and levels at the crib aftewarrds, were under the immediate direction of Mr. Wm. H. Clarke, the principal Assistant City Engineer, who attended personally to them until other duties and impaired health made it necessary for him to keep out of the tunnel. The final and very satisfactory result with regard to lines and levels, mentioned hereafter, prove the great care and accuracy with which Mr, Clarke conducted his operations.

INSPECTORS AND DOINGS OF THE DIFFERENT SHIFTS.

It was deemed a matter of great importance on the part of the Borad of Public Works to have a representative constantly in the tunnel, not only to see that the work was done properly, but to take prompt measures for its safety in case of accident or threatened danger. At first, Messrs. Herman Kroeschell, Edward Everett, and George Dewer were employed.

Mr. Kroeschell, an educated and experienced mining engineer. was principal inspector of mining, and directed the "trimming" shift, which worked the eight hours immediately before the masons commenced. He set the "patterns" by which the masonary was built, producing for this purpose the lines and levels given by the engineer in charge, by means of plummets, ranges with sperm candles, and spirit levels. His shift consisted usually of four miners and four other men, who at first pushed the loaded cars to and from the shaft, but afterwards to and from the nearest chambers, from which they were hauled by mules to the shaft and back again, either empty or loaded with brick, cement or sand. Only two of the miners usually were regularly trained men, the others being but picked laborers, who soon learned to use mining tools in the clay. The general custom was for two miners to work together for ten or fifteen minutes at a time with more than common vigor, and then rest. The pushers loaded the excavated earth into the cars, brought as near the face as possible on a movable truck. This shift, besides frequently carrying the face of the excavation five feet ahead, did all the trimming necessary to form the interior of the excavation as nearly as possible to the exact outside shape of the masonry.

The next, or mason's shift, was under the constant inspection of Mr. Everett, employed for years previously in this city as a very efficient inspector of sewers. The shift usually consisted of three masons, one mortar mixer, and four to six helpers, according to the distance between the chamber and the work. The water for mixing the cement mortar was all brought from the top of the land shaft in tank cars, made especially for the purpose. The principal cement used was that known here as "Clark's LaSalle," but there was also a considerable quantity of the Falls City Louisville, and some of the Akron, N. Y. The cement and sand were mixed together in equal quantities. It will be a matter of much interest when the tunnel is again entered for examination, to ascertain the relative degrees of hardness and probable durability of the different kinds of cement used. The average length of masonry laid by this shift was 12 feet a day, for the entire distance, but for the first 2,000 feet the greatest progress scarcely equalled this rate. Afterwards it sometimes reached 15⅓ feet a day; but this latter rate could only be attained by putting on a couple of miners during this shift. The earth they excavated could not be removed from the tunnel while the masons were in, and consequently delayed to some extent the operations of the next or principal mining shift; but this course enabled the contractors to advance the whole work two feet more a day than they could have done without it.

The principal mining shift was under the inspection of Mr. Dewer, an experienced miner. His chief duties were to keep the excavation within the proper lines and to watch carefully for the approach of bad ground, so as to be ready with bracing, or to take any other course the emergency might require. Mr. Dewer's health failed during the progress of the work, and he was succeeded by Mr. Edward Offerman, who continued till the tunnel was completed. This shift consisted of four miners and four pushers.

OPERATIONS ABOVE GROUND.

The operations above ground were under the immediate direction of M. John P. Offerman, the contractor's superintendent. There were two shifts of mechanics and laborers employed here each during twelve hours of the day. The whole force above consisted, generally, of one superintendent, one night foreman, two engine tenders, four topmen, one day laborer and one carpenter. Two mules were constantly employed, and one kept in reserve in case either of the others should fail. All the bricks were carefully inspected above ground, by Michel Whelan, an employe of the Board.

PLAN AND CONSTRUCTION OF THE CRIB.

Preparations for commencing operations at the outer end of the tunnel were early made, but owing to disappointments of the contractors in getting the necessary timber for the crib, and other delays, the foundations of the outer, and only one it was found necessary to build, were not laid till May, 1864. This was done on the north

side of the river about 800 feet west of the Light House. The dimensions of the crib as required by the specifications, are 58 feet horizontal measurement on each of the five sides, and 40 feet high. The inner portion, or well, has sides parallel with the outer ones, and 25 feet long each, leaving the distance between the inner and outer faces of the crib, or thickness of the breakwater, 25 feet. This breakwater was built on a flooring of 12 inch white pine timber laid close together. The outer and inner vertical faces and the middle wall between them were all of solid 12 inch white pine timber, except the upper 10 feet of the outside, which was of white oak, to withstand better the action of ice. Across the angles of the outer and middle walls were placed brace walls about 10 feet long, of solid 12 inch timber. The middle wall on each side of the crib was continued straight through to the outside wall. Connecting the outer and inner walls, and passing through the middle wall, were cross-ties of 12 inch timber, placed horizontally about 9 feet, and vertically one foot apart. The ends of all the timbers, where they passed through the outer and inner walls, were dovetailed and notched half and half into the timbers of the middle wall. All of the timbers used were carefully inspected and well jointed, which was mostly done by hewing, though nearly all of it was first sawed. It was found impossible, however, to get sawed timber of perfectly uniform dimensions. The floor timbers were laid on ground timbers placed directly under the outer, middle, and inner walls of the crib. Round 1½ inch bolts, 36 inches long, with large washers at the bottom, were placed vertically, 4 feet apart, to hold the ground and floor timbers firmly to the first two courses of wall timbers above the flooring. All of the wall timbers were fastened to each other by 1¼ inch square bolts 34 inches long, pointed and driven somewhat slanting into 1¼ inch auger holes, about 5 feet apart. The slant was given in opposite directions to the bolts nearest each other, to avoid the possibility of their being drawn out by the buoyancy of the timber, an accident which once occurred to a somewhat similar structure in the west.

Three rectangular openings, each 4 feet wide and 5 feet high, were made through the breakwater at different depths below the surface of the lak, so that water could be drawn from near the bottom, middle or top, as future experience might show to be best. These openings, and wells 4 feet square from them to the top of the breakwater, were timbered around in the same careful manner as the rest of the crib. Each well was provided on its inner face with slides for a temporary gate to cut off the water whenever thought necessary.

The floor and walls of the crib were all carefully calked. The interior of the breakwater was divided into seven water-tight compartments, made so by the calking already mentioned, and "matched sheathing" beneath the walls. The object of these water-tight compartments was to make it easy to build solid masonry in the whole of the breakwater at any time within the course of a few years, if it should be thought best. The whole of the outside surfaces of the outer and inner walls were sheeted with two inch plank carefully jointed, placed vertically and spiked on. Instead of pine, three inch white oak was used for the upper portion of the outside, to resist the ice. The upper 10 feet of each outside corner was protected by angle-irons, extending each way two feet, and one inch thick, and firmly fastened by 2 inch bolts. From the bottom to the top of the crib, and into which the angle-irons were let, there were ten pieces of white oak, 5×14 inches, fastened every two feet to the middle wall with 2 inch round bolts. Similar pieces 3×12 inches, 39 feet long, reaching rrom the top of the crib to the flooring, were fastened by the same bolts to the inside of the middle wall. It will thus be seen that apparently excessive care was taken to make the crib strong; but subsequent experience showed that this care was none too great.

LAUNCH.

The crib, when built, was in a horizontal position. In order to launch it, it was raised by screws and inclined at an angle of 1 in 12 towards the water. Seven ways were placed under it and extended out 64 feet into the river on trestle work. The river portion of the ways gave a great deal of trouble on account of the uneven and stony character of the bottom, and accidents caused by passing vessels. Everything being ready, the launch took place on the 24th day of July, 1865, when the crip glided without accident or delay gracefully into the water, in the presence of a large number of spectators.

SUPERINTENDENCE.

The contractors employed as their foreman, in the construction and launching of the crib, Mr. Geo. R. Bramhall, a mechanic of unusual skill and judgment. The Inspector placed over the work by the Board was Capt. A. S. Bergh, who had previously had the immediate charge of the lake borings made before the work was let.

PLACING AND FILLING OF CRIB.

Immediately after the launch, the contractors towed the crib out to its position in the lake. As soon as the bar was passed, three small gates near the bottom of the crib were opened, and the draft of water, which at first was but a little over 8 feet, increased soon after reaching the anchoring ground to 21 feet. A mooring screw, opposite the intended position of each angle of the crib, had been placed under the direction of Mr. Clarke. To each mooring screw a 1½ inch chain cable was attached, and the loose end of the chain fastened to a buoy. Unfortunately, lake propellers had destoyed three of these buoys, and it was thought most expedient to substitute for the sunken chains ordinary anchors and hemp cables. As soon as the crib was brought near its position, the work of filling with loose rubble was commenced. Very soon the crib got "out of trim," and one corner of it rested on one of the low bars, peculiar to the lake at this distance from the shore. After some time had been lost in vain efforts to get the crib righted and into its exact position, the Board became alarmed for its safety, in case a severe storm should arise, and directed that no expense should be spared that might seem necessary to the engineer to secure it with the utmost despatch. A wrecking pump was at once employed. By means of this, sufficient water was pumped into or out of the crib, as occasion requirek, to right it. The partitions between the compaitments failed, and it was a matter of rejoicing that they did, for otherwise the removal of the wrecking pump from one sompartment to another could not have been made in time. Three powerful tugs were hired, which, by the aid of sufficient tackle, finally towed the crib to its exact position.

STORM AND ITS EFFECTS.

Immediately the contractors resumed the operation of filling the crib with stone, but very soon after a violent storm set in and drove the vessels loaded with stone into the harber. This storm continued for three days, and threatened, before it abated, to do serious, if not fatal injury, to the crib. In order to hold it in its position as firmly as possible, the wrecking pump was kept at work to fill it with water, the stone thrown in previously not being sufficient to hold it down. During the height of the storm, every wave caused a perceptible rocking of the crib. The angle-joints of the inner and middle walls began to separate, and for a time caused intense anxiety. When the storm was over two of the inner angle-joints had parted an inch on top, and the entire crib had worked, against wind and waves, thirteen feet, and the northwest angle was 3¼ft lower than the south-east. The great difficulty there would have been in restoring the crib to its exact position, and the fear there might be another storm in the meantime, prevented any attempt of the kind from being made. The very slight deflection this rendered necessary in the line of the tunnel was of no practical importance whatever, though regretted, and the variation of the sides of the crib from perpendicular, though a constant eye-sore, did not affect its stability. The filling of the crib with stones was proceeded with as fast as the contractors could, and since it was completed, about the middle of August, no variation whatever in the position of this structure has ever been perceived. A slight tremor is sometimes felt during severe storms and when large fields of ice are passing. The rubbing of field ice against the crib is occasionally accompanied with a fearful noise. At such times the crib appears to a spectator on it, to be an immense plough moving through the ice. On several occasions the broken masses lodged on the south side of the crib, forming banks several hundred feet long, and reaching from the bottom of the lake to ten or fifteen feet above the surface.

The breakwater portion of the crib being filled with stone, the contractors erected over it a temporary wooden covering, with a light house on top, and rooms above and below for the accommodation of their own men as well as inspectors employed by the Board. It may be said in passing, that the air was so pure at this dwelling-place as to cause complaints, at first, from the cook, of the voracious appetites of the men. The reputation of the crib for healthfulness is still maintained, the present keeper being now quite vigorous and hearty although apparently a feeble consumptive when he went there to live about eighteen months ago.

CYLINDER AND LAKE SHAFT.

The cast iron cylinder for the lake shaft was made in Pittsburgh, by Messrs. James Marshall & Co., who also made the one for the land shaft. It consists of seven sections, each nine feet in length, nine feet internal diameter, 2¼ inches thick, and in all other respects like the one for the land shaft, except that the lowest section was turned on the outside to make it penetrate the clay more easily, and the upper end was provided with two gateways for the introduction or exclusion of the lake water. The gate-ways are each 54 inches high by 32 inches wide, and placed with their tops below the lowest known level of the lake. Each gate-way was provided with a sliding gate on the outside of the cylinder, raised by a screw worked at the top of the cylinder. Provisional arrangements were made at each gate opening for forming chambers on each side, in case it should ever be necessary to repair either gate, by simply sliding in temporary gates. The sliding faces for those temporary gates, as well as of the permanent ones, were made of "composition." Inclined ways were placed inside of the crib, during its construction, to aid in lowering the cylinder to its place, but the storm already mentioned destroyed them. The lowest and next cylinder sections were put together on an incline. They were held in place when required by chains on the outside secured to the lower end of the bottom section, and a brake over the upper side of the cylinder. They were lowered gradually on the incline by means of screws attached to the upper flange. These screws had to be removed, of course, for every new section put on. Care was taken to have sections enough together, before removing the chains from the bottom of the cylinder, to reach above the water. This required five, or 45 feet altogether, to be sure. A false bottom of wood was put into the cylinder at its lowest section, to keep out as much water as practicable. This gave the cylinder great buoyancy when sunk to a depth of 30 feet, and made it very easy to handle with blocks and falls placed over-head. On being lowered the cylinder sunk by its own weight two or three feet into the clay when the false bottom stopped it. A hole was then bored through the false bottom and the cylinder went down several feet further by its own weight. After the sixth or gate section was put on and the false bottom removed and excavation made within, the cylinder was continued to sink by its own weight. After the top section was put on, a moderate force only was necessary to push the cylinder down 23 feet below the bottom of the lake. Below this point the work of sinking the shaft was substantially a repetition of that at the shore end of the tunnel, except that no water was met with, and no pump ever put in or required. The little leakage that occurred was easily removed in buckets.

An extension eastward, about 50 feet, was made, in anticipation of the possible extension of the tunnel, at some future day, still further out into the lake. This was provided with the necessary sump and bottom on which to place another iron cylinder. The extension was of great service during the construction of the work as a turn out for the cars, and afforded, by means of a 6 inch tube, sunk perpendicular from above the surface of the lake to its outer end, an excellent opportunity to start the line of the tunnel below with great accuracy towards the deflecting point in the middle.

The London and Northwestern Railway Co., of England.

This great railway company controls 1960 miles of road, and employs 40,000 persons; it owns 391 passenger engines, and 1544 freight engines; its passenger traffic requires 2,722 coaches, while its freight traffic demands 39,581 cars, or wagons; for the year ending June 30th, 1874, it carried 42,511,771 passengers, and 24,292,894 tons of freight; its revenue from all sources was $44,000,000. It dispatches each way over its main line between London and Rugby, daily, 64 trains of all kinds, 22 being passenger; of these, 30 express and mail trains run at 40 miles an hour; 5 run at 36 miles an hour, and the rest from 19 to 28 miles an hour. The total train mileage of all trains for the above mentioned time was 30,558,522. Passenger trains have increased from 312 and 403 feet in length, and 123 and 149 tons in weight in 1863, to 613 and 811 feet in length, and to 232 and 257 tons in weight in 1872. For the heavier express trains it has been deemed expedient to use coupled engines.

To carry on the great traffic of this road, particular care is taken in the organization and training of the staff of employes, the efficiency of which is kept up by the practice of selecting men for promotion by merit, irrespective of length of time of service or any other circumstance.

In working the line, the goods trains run with full loads between the most important stations. The traffic at the intermediate stations is collected by a service of local trains, and conveyed to centres such as Rugby, Crewe, and other junctions, there to be properly marshalled and classified, and from thence to be forwarded by the through trains without further delay. The company have 171 engines constantly employed in marshalling and classifying the trains in the sidings, which in the year mentioned performed 613,472 hours of labor in shunting, at a cost to the company of $760,000.

All English railway companies are now common carriers. The London and Northwestern Railway company have, altogether, 1600 men and 1000 horses engaged in the goods business in London. Goods are collected conveyed, and delivered, between all the important towns in England within the day of 24 hours, and between England and Scotland and the ports of Ireland within two days, or 48 hours. Thus the Yorkshire merchant attends the London wool sales; he makes his purchases one day, and the wool is in his warehouse the next. The Lancashire spinner attends the Liverpool cotton market, and expects his cotton delivered, and probably in actual consumption, the next day. The dead meat from Scotland, the poultry, butter and eggs from Ireland, are all despatched with the narrowest margin of time to meet particular markets, and all is accomplished with certainty.

To keep such a traffic in motion with the regularity and system that is necessary to prevent accidents and to accomplish the ends proposed, requires the ceaseless watchfulness and activity of the staff, and the service which is performed, although not generally understood or appreciated, entitles them to high praise.

Prompt renewal of subscriptions expiring with our last number is solicited.

ENGINEERING NEWS.

SATURDAY JANUARY 8th, 1876.

GEO. H. FROST, - Editor and Publisher.

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Notices of Meetings.

The annual meeting of the Chicago Rifle Club for the election of Officers and general business, will be held at the Club Room of the Sherman House, at 2 o'clock, P. M., Monday, January 10, 1876

R. S. THOMPSON.
Secretary.

The Chicago Academy of Sciences—Tuesday, January 11, at 7:30 P. M., at 263 Wabash avenue.

The Microscopical Society—Friday, January 14, at 7:30 P. M., at the Hall of the Academy of Sciences, 263 Wabash avenue.

A REVIEW OF ENGINEERING ABROAD FOR 1875.

In continuation of our remarks of last week upon the progress of engineering in the United States, let us take a survey of what has been accomplished or initiated in other countries.

Since the successful completion of the Mont Cenis and some other lesser tunnels, the projectors of new enterprises seem not to shrink from any obstacle. The St. Gothard tunnel, to be when completed 48,936 ft. in length, has been rapidly advanced; the headings, 8 ft. 3 in. by 8ft. 3 in., driven from each end, are in some 14,000 ft., but the enlargement to full size is very much behind. Profiting by previous experience, the contractors use machinery and powerful explosives to the best advantage, and it is thought that the tunnel will be finished in 1879 or 1880. A tunnel under the Severn is being carried forward by the great Western Railway Co. It will be about 4½ miles long, one half of which length will be under the river. A bridge of 3960 ft. across this same river was also commenced in June.

There is a scheme, which is regarded with favor, for crossing the Mersey, between Liverpool and Seacombe, by means of an iron tunnel to be sunk at the bottom of the river in a previously excavated trench. Some experiments, as to the practicability of making the joints under water between successive sections, have demonstrated that there is no unsurmountable difficulty in the way. There is another project for piercing the Simplon with a tunnel of 60,350 ft. Then we have the long mooted scheme for a channel tunnel, which has again shown signs of life. Soundings across the English channel, and some borings have been made; it is thought that the continuity of a stratum of grey chalk, practically impervious to water and with no fissures, to be penetrated by the tunuel at a depth of 250 ft. below the bottom of the channel, is assured. There is scarcely any other narrow channel or strait which has not been spoken of as practicable to be tunnelled.

The English channel suggests the Bessemer steamship; this ship designed to obviate seasickness, during the passage from Dover to Calais, by means of a swinging saloon which shall not roll with the vessel, is, so far as this saloon is concerned, considered a failure, and is advertised for sale. The twin, or double steamer Castalia, built with the same object in view, has made several successful trips.

A previous season of scant rainfall in the British Isles has caused a movement during the past year in many cities for an increased water supply. It has been stated that only some four or five of the larger cities found their present source of supply adequate.

As the population and manufactories increase along the rivers from which many places take their water, and into which all the drainage flows, the pollution of the natural water courses calls loudly for a remedy. Royal commissions and Parliament by enactments have again the past year endeavored to protect the public health; the satisfactory disposal of sewage is a difficult problem, and the branch of Sanitary Engineering is calling to its service some of the best Engineering talent abroad. Such a task is already beginning to confront the larger cities in this country, and our engineers must hold themselves prepared for the occasion. A mere enumeration of the different methods advocated, and experimented with in England with varying success, will show how pressing is the need. There may be mentioned the Phosphate Sewage Co's process the Native Guano or A. B. C., Gen'l. Scott's lime and cement process, Hope's irrigation, Bailey Denton's intermittent downward filtration, and Capt. Liernur's or the pneumatic system.

Another branch of engineering which is likely to develop itself in this country is the construction of pneumatic despatch lines and the machinery for their operation. They have been extended in England, France and Germany; they have been very completely described and illustrated in *Engineering* the past year.

As it was desired to make connection between the Trent and Mersey Canal and the river Weaver, where they approach one another, to enable vessels to pass from one to the other, a wrought iron extension of the canal was carried towards the river, and a double hydraulic lift, with tanks or open pontoons, of section equal to the canal, and length sufficient for the longest canal boats, was erected and completed in July. The lift is over 50 ft., one boat ascends while another descends, and the time occupied is about three minutes.

The celebration of the fiftieth anniversary of the opening of the Stockton and Darlington Railway, the first public railway worked by steam, took place Sept. 27. It was thought a curious coincidence that the announcement was made by telegram at the dinner, of the signing of the contract for the first Chinese railway, and that the first rails would be rolled for it that afternoon at Stockton. The introduction of railroads in the Chinese Empire it is suggested will open a new field for engineers, but it is probable that Chinese conservatism will make their extension very gradual. In this connection it may be stated that an engineering college is in successful operation in Japan, with about two hundred pupils.

A Belgian bridge, over the Volga, to be 3666 ft. long, was commenced in August. The construction of the bridge over the Tay, at Dundee, a viaduct some two miles long, is being pushed with energy; here, as often elsewhere, the most of interest, in an engineering point of view, centres in the foundations; these have given much trouble. The piers are sunk by the pneumatic process. The Alexandra Dock at Newport, was opened in April. It is 2500 ft. long, 500 ft. broad, and communicates with the river Usk by locks. Victoria Dock, at Dundee, was opened in August. The removal of obstructions to the navigation of the Danube, among which are the rocks known as the Iron Gates, has been decided upon, if not already commenced.

The narrow or metre gauge system of railways is being introduced in Switzerland, where its peculiar advantages, as claimed by its friends, will be especially applicable.

The Khedive of Egypt seems to be a very progressive ruler; he is rapidly introducing improvements, and is aided by several foreign engineers. Irrigation works occupy much attention. Prof. Watson, of Michigan University, on his return from the observation of the Transit of Venus at Pekin, China, was employed by the Khedive to measure a base line for a trigonometrical survey.

Some very interesting experiments for utilizing the power of waves for the propulsion of vessels have been related in papers read before the Institution of Naval Architects, of England. No less authority than Mr. Froude vouches for the correctness of the results obtained with a working model, and pronounces the scheme for wave propulsion "original, novel and scientific."

Some American improvements have finally obtained a foothold in England and upon the continent. Pullman cars have been introduced and received with favor. After a thorough competitive trial of continuous brakes in England, the Westinghouse automatic brake is considered the most efficient.

The Russian circular iron-clads, the second of which has been recently launched, are a great innovation in the shape of vessels of war. The Novgorod is 101 feet in diameter, the Admiral Popoff is 120 feet in diameter, and the draught is only 12½ or 13 feet. They have called forth much comment in English journals, and it is acknowledged that for a given amount of money, an iron-clad of much greater defensive power, and of greater offensive power, so far as guns are concerned, can be produced on the circular than on any other principle. They have great steadiness in a sea-way, but it remains to be proved whether a speed of more than perhaps 8 knots an hour can be obtained without excessive engine power.

We can but briefly allude to the proposition to drain some 300,000 acres of the Zuyder Zee; the diversion of the Scheldt and dock improvements at Antwerp; a projected ship canal from Amsterdam to the North Sea; a scheme to flood the Great Desert in Africa; the advancement of railways in Brazil and Peru; the geological survey of Brazil in progress under Prof. Hartt, of Cornell University; improvements at Montreal and Quebec; deep-sea soundings by means of piano forte wire at a depth of 4575 fathoms, with a sample of the bottom; a balloon ascension to a height of about 46,000 feet, and M. de la Bastie's process for annealing glass.

A CHANCE FOR IDLE CAPITAL.

Twenty years ago the manufacturing interests of the country were but in their infancy. We exchanged cotton, grain, and other products of the soil for the manufactured articles of England, France and Germany. Our civil war found us largely dependent on other nations for supplies of all kinds. That event, however, gave to the manufactures ot the north a wonderful impetus. The million of men who had withdrawn from the farms and the workshops of the country, were replaced by the creations of the national inventive genius, and a multitude of labor saving appliances soon made their appearance.

Following the war came the period of apparent prosperity which culminated in the financial panic of September, 1873, from the effects of which we are still sorely suffering. But, during that remarkable decade our manufactures took a great stride forward, and in several articles we have long since driven out all foreign production. It has been, however, in the iron trade that the greatest triumphs have been gained. Railway construction was the principal stimulant thereto, and with such an enormous home demand as was thus created, and "protected" from foreign competition by an almost prohibitory import tariff, it is not to be wondered at that Iron soon occupied the vacant throne of the defunct King Cotton, and its lords made laws for the people. While their furnace fires lighted up the bleak hills of Pennsylvania and New York, the iron masters were at Washington clamoring for more "protection"; for more "encouragement of the iron interests of this great and growing country", and always with success. Whoever was able to run up a structure, however rude, for smelting the ore, made money, and so the furnaces multiplied and the iron masters counted their gains, until that dismal day when Jay Cooke and the Northern Pacific Railway went down dragging with them railways, blast furnaces, paper towns, and a hundred other balloons that had been sailing along so smoothly and prosperously but a few hours before. The most of the furnaces have gone out of blast, and are likely to remain so for some time to come; the most of the railway companies are bankrupt, and will be so for a long time to come, while the town builders are perhaps the most impecunious of the whole crowd of inflationists that are clamoring for soft money and future repudiation, that now infest this country.

At present, the furnaces in blast are more than able to supply the needs of home consumption; the increase in the prices of labor, and the cost of mining the coal and iron in England, together with the introduction of improved processes by the great iron and steel manufacturing establishments of this country, in conjunction with the present tariff, have closed our markets effectually against foreign competition; we think, therefore, that it is time to turn away from iron, and see if in the development of some other branches of industry, there are not numerous chances for the employment of capital now lying idle, and in their encouragement bring relief to the iron interest itself and all its dependencies.

Let the capital of the country be applied to the growth and manufacture of sugar from the cane and sugar beet; to the growth and manufacture of cotton, wool, silk and flax, and to the manufacture of a great variety of other articles which we are now obliged to buy from other nations for gold, and there would soon be a demand for improved machinery, and for skilled labor in its manufact-

ure, and thus in a short time the wheels of trade would be set in active motion, and railway companies, manufacturers, farmers, merchants, and the people generally would feel the benefits, and instead of advocating repudiation and national dishonor, the whole nation would unite in showing to the world an example of material progress and of good government in the second century of our existence that would far outdo any of the marvels of the past.

COMMITTEE OF NOMINATIONS.

At the meeting of the Civil Engineer's Club of the Northwest on Tuesday evening last, several very important questions for future discussion were suggested. We desire here to refer to one only, viz., the appointment of a Committee on Nominations.

In the infancy of societies like the C. E. Club, it is not usual to examine very closely into the qualifications of candidates for membership, and provided they are vouched for, as to personal character and professional ability by any member of the society, they are elected. As the society grows in numbers and influence, however, it becomes an object to be a member, and it sometimes happens that an individual of unenviable reputation, or one who has an "axe to grind," or a project for which he wants an indorsement to, and the publicity to be obtained by bringing it before a society meeting, or perhaps who has a personal dislike to some member which he wishes to exhibit in public, desires to join the association; it is not an agreeable duty to refuse to place the names of either the one or the other in nomination for membership, and it would be very mortifying to both the candidates to be rejected when their names came up for election. To provide for such cases as these it is proposed to create a committee on nominations. In the Institution of Civil Engineers it is necessary that at least four members and ten associates shall certify to a personal knowledge of the candidate and that he is properly qualified to be admitted to the society. The proposal so endorsed is then submitted to the Council who decide whether or not the candidate shall be admitted to ballot, and if he is, then to what class he is to be presented for ballot. Similar precautions are observed in the American society of Civil Engineers, and it is by this discrimination that tne standard of a society is raised, its influence strengthened, and a membership in it comes to be considered a privilege worth possessing and a valuable endorsement as to qualifications and abilities.

The Civil Engineers' Club of the Northwest is the second most influential engineering society in this country, and with the growth of Chicago and the Northwest it must grow in influence and power. With the revival of trade and the return of prosperous times, the engineering profession, now suffering severely, must come to the front, and in the execution of the great public works of improvement that must necessarily be projected, the best engineering talent will be the most in demand.

It is inevitable that the two societies of this country, the one with headquarters at New York, and the other at Chicago, must take the lead in furnishing the men and talent that will be wanted. The day of prosperity is not very far away now, and it is time for this society of the West to seek to raise high its standard of qualifications for membership so that it will not be merely a name but a reality. The proposed committee on nominations will be one that is never known except by the President, who will appoint it, aud it will be changed as often as the President sees fit to change it. A person seeking to become a member will have his name handed *at any time* in the interval between the meetings, to the President by any member; the President submits the name to the committee on nominations, which institutes the necessary inquiries as to the qualifications of the candidate, and if they are favorable the candidate is nominated and elected; but if unfavorable the name never comes back, and outside of the nominee, the President and the committee, it is never known that the party rejected was ever a candidate for membership. These are the details of the proposed scheme, and a few hints as to the reasons for its introduction, and it is to come up for discussion at the next meeting, when it is desirable that as large a representation of the members be present as possible. As in questions generally, there are two sides to this one, and a full and free discussion as to its merits and demerits is very desirable. We see no reason, also, why non resident members should not give an expression of their opinion in the matter, and to those who desire to do so and will be brief and to the point the columns of ENGINEERING NEWS are open.

Our National Surveys.

The January number of the *Galaxy* contains an article on the subject of our National Surveys, by Capt. Raymond, of the Corps of Engineers, U. S. army. While profesedly devoted to an account of the progress which has been made in reference to our knowledge of our vast unsettled territory, it is really an attack upon certain surveys now in progress, and chiefly upon that in charge of Dr. Hayden. As such, it is an indication of the desire of the officers of the Corps of Engineers to re-open a quarrel which was caretully investigated by a committee of Congress two years ago and decided against them. The military occupation of the frontiers of settlements, and of the lines of communication through the territories, has necessarily required certain reconnaisances, or preliminary surveys, and in the course of these surveys much valuable information has been obtained in relation to the topography, mineral and other resources of the territories. Nearly all the valuable work of this character has been actually performed by civilians in the temporary employ of the Bureau of Engineers; and it was not supposed, until within a few years, that there was any growing desire on the part of the officers of this Corps, to have a monopoly of this work. The actual care of the vast public lands is committed by law to the Secretary of the Interior, and it thus became a part of his duty to provide for the proper exploration and survey of these lands. Accordingly from time to time expeditions have been organized for this purpose. Those which have attracted public attention most, are the recent ones respectively under Major Powell and Dr. F. V. Hayden, and it is against these that the batteries of the engineers have been directed. The attack of two years ago was along the whole line, against all public works entrusted to the direct management of civilians, and specially against the operations of Dr. Hayden, in Colorado. A certain young officer of engineers, Lieutenant Wheeler, was the marshal of the host, but he was ably aided by the veterans of the force. They approached members of congress in various ways, and even went so far as to induce the President to give a recommendation in their favor. Thus prepared they marched boldly to the attack, and were ignominiously defeated. Congress decided, and wisely too, to leave the care and control of these works in the hands of the Secretary of the Interior, and expressed the opinion that the Secretary of War should limit the operations of the army officers to surveys required for military purposes alone.

The whole tenor of the article by Capt. Raymond, goes to show that the attack is to be renewed in the present Congress. Perhaps to most of our readers it may seem at first a matter of indifference as to the result of the contest. It may appear that it would be more economical to have the engineers do the work, because these officers are alreedy in the pay of the Government; and there are other grounds which at first appear tangible. But our space will not admit of a full discussion of the question, and let it suffice to state briefly a few reasons vhy we concur in the decision reached two years ago.

First then, to the Engineer Corps has been entrusted the management of the construction of fortifications and military roads, the improvements of the harbors and rivers, the construction of lighthouses, and the survey of the great lakes. These great works have required more than the skill and numbers of these officers, so that they are in most cases actually entrusted to educated civilians, the army officer nominally in charge of a particular work being often little more than a disbursing officer.

Secondly. We do not believe (and this is Capt. Raymond's sheet anchor,) that the only place in the country where proper training is provided for this kind of service is the Military Academy at West Point. There are many Schools of Science and of Engineering in the United States, which provide better and more effective means for this education, and it is doubtful whether the men thus educated can be or ought to be, compelled to be the subordinates often of officers whose qualifications are simply rank in the regular service of the army.

Third. While the Engineer Corps does actually contain many officers eminent in science, there are notoriously many, very many, whose qualifications have no other attestation than that of membership in the Corps, and these are the men whose arrogance and ignorance, always in a constant ratio, have made the subordinate service so distasteful to civilian employees.

Fourth. In regard to the expense of conducting the surveys. it appeared from the investigations made two years ago, that the same number of civilian employees was necessary in the one case as in the other, and that the military fuss and pomp, not only doubled and trebled the expense, but made the expeditions a defiance to the Indians, and thus often hazardous and unsuccessful.

Fifth. The surveys conducted by civilians under the direction of the Secretary of the Interior, have been unmolested, as a rule, by hostile tribes, and have produced results commensurate with the expenditure of money involved.—*Ann Arbor Register.*

PUBLICATIONS RECEIVED.

On the Dynamical Law of Horse-Power of Steam Boilers, by John W. Nystrom, C. E.

Beet Root and Beet Root Sugar: the description of all the processes of manufacture being condensed and simplified and adapted to the use of the farmer and the small manufacturer: by Edward Lefroy Cull, of the Canada Company, Toronto. *Second Edition.*

Annual Report upon the Preservation of the Fall of Saint Anthony, Construction of Lock and Dam at Meeker's Island, Minnesota, and Improvement of the Minnesota River, in charge of F. U. Farquhar, U. S. A., being Appendix H of the annual Report of the Chief of Engineers for 1874.

Report of the Board of Engineers to the Citizens Association upon the Chicago Water Supply.

NARROW GUAGE RAILWAYS.

It is very evident that, in spite of great opposition to its adoption, the narrow guage railway is growing in favor. The cost of building is certainly less than that of the standard guage, and now, after a test of several years it is asserted by many practical railroad men that a considerable saving is effected in operating it, as compared with the standard. The system is warmly advocated by a very prominent foreign engineering journal, and in this country one of the largest locomotive manufacturing companies is making a specialty of narrow guage rolling stock. Our attention is also called to a statement that the Delaware, Lackawanna and Western R. R. contemplate reducing their road to the narrow guage, and expect that the saving to be effected by the reduced cost of operating the road will soon be reimbursed to them. The NEWS invites correspondence on the subject of Narrow Guage Railways. and hopes that if there is anything new on the subject it will be communicated.

Monroe, La., December 23, 1875.

EDITOR NEWS:—I desire to be informed on the following points, viz.:

What is the method adopted in your state for the repair and construction of public roads?

In what body is reposed the authority of making laws on the subject?

What class of officers are charged with the execution of the said laws?

What, if any, penalties are imposed for failing, neglecting or refusing to work the public road?

What court has the jurisdiction to try?

What proceedings are necessary to be taken to bring the case before the courts? and what constitutional question has been raised in the premises?

Please answer through the columns of your valuable journal and oblige, Yours truly,

BENJ. McLEVAN.
Parish Surveyor.

We will be obliged if some one of our County Surveyors will answer the above questions. In this County (Cook) there never are any repairs of public roads made: we do not know of any person having authority that ever *did* do anything, and such a thing as *penalty* for neglecting to do what ought to be done is unknown. All these matters in this vicinity are under "ring" government, and will form the subject of extended remarks in ENGINEERING NEWS at some future time. Meanwhile as there must be some laws relating to common roads and some counties where they are observed, we hope the questions of our correspondent will be fully answered as soon as possible. The whole subject of common roads, their construction, and management, is a very important one, and we know of no persons more competent to give information concerning them than the County Surveyors. [Ed.

At the Civil Engineers' Club Meeting on Tuesday eveniug, the dues for 1875 of all the members were remitted' Those who have paid already will have the amounts returned.

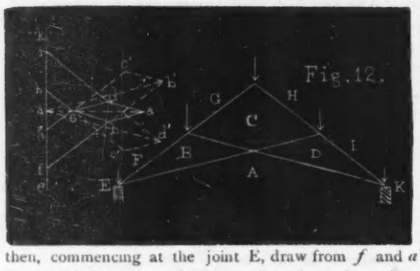
GRAPHICAL ANALYSIS OF ROOF TRUSSES.

BY CHAS. E. GREENE, A. M., PROF. OF CIVIL ENGINEERING, UNIVERSITY OF MICHIGAN.

IV.

When it is desired to strengthen the rafters in a roof of moderate span by supporting them at their middle points, a simple means, often employed, is to spike on a piece from the lower end of one rafter to the middle of the other, as shown in Fig. 12. The two pieces may or may not be fastened together where they cross.

At the first glance we should say that, to draw the diagram, we must lay off the load line $k\,e$, divide it as usual,



then, commencing at the joint E, draw from f and a lines parallel to F B and B A, and prolong them (see the dotted lines) until they meet at b'. Next, for the joint F G, we should get the lines $b'\,c'$ and $c'\,g$. For the apex we should have three lines, viz., $k\,g$, $g\,c'$ and a line from c' parallel to C H, to strike k. There is evidently something wrong here. If we start from the other point of support K, we shall obtain the remainder of the diagram in dotted lines, and find that we have two points marked c', some distance apart, which ought to come together; we also have two conspiring forces, $g\,c'$, and $k\,c'$, whose vertical components ought to balance $k\,g$.

Abandoning this diagram for the present, let us start at the apex of the roof, where we may feel sure that there are but three forces, of which one is known. Taking the load $k\,g$ at that point, draw the full lines $g\,c$ and $c\,k$. Next, for the joint G F, starting with $c\,g$, pass down $g\,f$ and draw $f\,b$ and $b\,c$. The joint H I will similarly give the figure $i\,h\,c\,d\,i$. Lastly the joint A C will add $b\,a$ and $a\,d$ to the stresses $d\,c$ and $c\,b$. Here again we find two points a widely separated. To make equilibrium for the joint E, therefore, as the diagram now stands, we have $a\,b$, $b\,f$, $f\,e$, $e\,a$, and a force $a\,a$ required to close this polygon. This force can be no other than the horizontal thrust which must be supplied to keep this truss from sliding outwards on the wall-plates, on the supposition that the points of meeting of two or more pieces are true joints (ones about which the parts are free to turn).

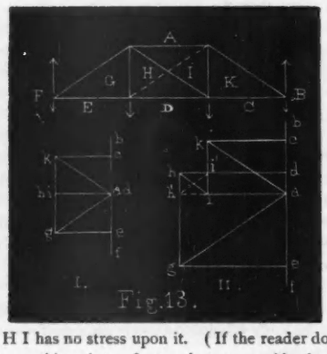
This horizontal reaction may come from the wall, or a tie-rod from E to K will accomplish the same end. The pieces of this truss are all in compression. That the truss is not in equilibrium without this resistance at E and K is seen, if we suppose that E and K are not prevented from sliding laterally; the joint A C will drop, the joints F G and H I will approach one another, and the apex will rise. This change will take place unless some restraining force is applied. The trouble arises from the existence of the four sided figure surrounding the space C, which figure is free to change its form. A tie from the apex to the joint C A would prevent the movement, and it would supply the missing line $c'\,c'$ in the dotted diagram. In that case it is well to note that the stress is greater in most of the pieces than when the thrust comes from the wall. A strut from the joint F G to the joint H I would also make the truss secure; the reader can try the diagram with that change for himself, and see what piece has its stress reversed by the change. The supporting force at E might now rather be represented by a line from e, upward to the right, to a, than by two rectangular components; and similarly for the one at K.

As these two trusses are usually made, reliance against change of form, when no horizontal thrust is supplied, is placed upon the stiffness of the rafters, which are of one piece from ridge to eaves, and on that of the two braces. The bending moment, at the joints where movement would take place, comes from this otherwise unbalanced horizontal thrust at the wall plates. Bending moments on a rafter will be considered later.

It will be noticed that $c\,d$ equals $b\,a$, or that the thrust is constant all along the brace. This would naturally be expected; for the the component of the load at the joint H I which starts down the brace will pass to E without being affected by crossing the other brace; and if it were not for the tendency to rotate, spoken of above, spiking the two braces together would be needless, were it not for the reason that the braces are better able to resist thrust by mutually staying one another.

A consideration of the trapezoidal truss, represented by Fig. 13, will bring out two or three points which will be of use in the analysis of other trusses. In this case, let us suppose the load to be on the lower part, or bottom chord, of the truss; in order to separate the supporting forces from the small weights on the ends of the truss, and to enable the latter to come consecutively with the other weights in the load line, let us draw the supporting forces above the tie, instead of below as before. The rectangle formed by the two vertical and two horizontal pieces might become distorted; we will therefore introduce the brace H I, represented by the full line. The dotted line shows a piece which might have been introduced in its place. The rectangle is thus divided into two triangles and movement prevented.

If the truss is symmetrically loaded, or C D=D E, we shall get the first stress diagram. The stress on each vertical is equal to the load at its foot, and, if the load had been on the upper joints, no stress would have been found on the verticals. It will also be seen that the



piece H I has no stress upon it. (If the reader does not clearly see this point, refer to what was said about the dotted line in Fig. 9.) It is therefore evident that a trapezoidal, or queen-post truss, when symmetrically loaded, requires no interior bracing. This fact might be readily seen, if we considered the form assumed by a cord, suspended from two points on a level, and carrying two equal weights symmetrically placed.

The second stress diagram will be drawn when the weight on the joint C D is less than that on D E. Let us suppose that $b\,c$ and $e\,f$ are of the same magnitude as in the first diagram, and let the span of the truss, or distance between supports, which we shall denote by l, be divided by the joints into three equal parts. The first step is to find the supporting forces. Since equilibrium exists, if each external force be multiplied by the perpendicular distance of its line of action from any one assumed point, which distance may be called its leverage, and all the products be added together, those which tend to produce rotation about this point in one direction being called plus, and those tending the other way minus, it is necessary that the sum of these products shall be zero; otherwise the rotation can take place. A convenient point to which to measure the distances will be one of the points of support, for instance, the right hand one. Then we shall have

$$A\,F.l - F\,E.l - E\,D.\tfrac{2}{3}l - D\,C.\tfrac{1}{3}l - C\,B.0 + B\,A.0 = 0 \quad \text{or}$$

$$A\,F.l = F\,E.l + E\,D.\tfrac{2}{3}l + D\,C.\tfrac{1}{3}l \quad \text{therefore}$$

$$A\,F = F\,E + \tfrac{2}{3}E\,D + \tfrac{1}{3}D\,C$$

If D E be taken as 3 C D,

$$A\,F = F\,E + \tfrac{7}{9}E\,D.$$

It is plain that the object of taking the point or axis at B is to eliminate B A, and have only one unknown quantity A F. Lay off this value at $f\,a$ and then $a\,b$ equals the remainder of the load. This method of determination is called *taking moments*, and is at once the simplest and most generally applicable.

The point a being thus located, we can proceed to draw the second diagram. The construction requires no explanation but we will simply call attention to the fact that a compressive stress is now found to exist in H I. If, in place of the diagonal represented by the full line, the one shown by the dotted line is now supplied, the reader can without difficulty trace out for himself the change in the diagram which is denoted by the dotted lines and the letters marked by accents. The stress on this diagonal will be seen to be tensile, while it is worthy of notice that the only pieces affected by the substitution of one diagonal for the other are those which form the quadrilateral enclosing the diagonals.

If, at another time, this excess of load might fall on D C in place of E D, it is evident that the stress on either diagonal would be reversed. Now, as a tension diagonal is likely to be a slender iron rod, which is of no practical value to resist a thrust, while the compression member, unless made fast at its extremities, will not transmit tension, a weight or force which may be shifted from one joint to another may require the designer to have two diagonals in the same rectangle or trapezium, or else to so proportion and fasten one diagonal as to withstand either kind of stress. Where both diagonals occur the diagram can still be drawn. Determine which kind of stress, tension or compression, the two shall be designed to resist, and then, on drawing a diagram, and arriving at a particular panel or quadrilateral, try to proceed as if only one of the diagonals existed. If a contrary stress to the one desired is found to be needed, erase the lines for this panel only, and take the other diagonal. In the treatment for wind, yet to be taken up, this method must often be used, since the wind may blow on either side of the roof.

This truss can be used for a bridge of short span.

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Surveyor's Record Book.

Shawano, Wis., Jan. 3, 1876.

EDITOR NEWS:—No appropriate reply has been made to "J. B." on page 108, Vol. II, in regard to the publication of "county surveyors' record books."

It is generally conceded that a properly and systematically arranged "county surveyors' record book" or set of books, well printed upon good paper of a size of about 8 1-2 x 14 inches, in book form, would be a very valuable and convenient acquisition to all county surveyors in the public land states.

Now, I would respectfully suggest that all county surveyors who feel personally interested in this much needed improvement should submit to the editor of Engineering News as soon as practicable, for examination and approval:—proposed plans for blank plats of sections, with the necessary detail for record book as has been suggested by long experience; also a systematic tabular form for recording the established corners both government and subdivision; also a systematic tabular form for recording the data of field operations of measuring angles and distances—i. e. suitable for and adapted to the use of the open sight vernier compas or vernier telescope compass, such as are most in use throughout the public land states; also a suitable blank county surveyors' official plat arranged in conformity to the county surveyors' record book,—all to be as simple in design and as systematic in detail as will be found compatible with the interests of land owners as well as surveyors, by offering all requisite information in accordance to the requirements of the various laws of the respective public land states, where the present system of surveys is adopted.

Similar publications have been in use for some time in the offices of registers of deeds, for deeds and mortgages, etc., effecting a great saving of labor, besides making a much neater appearance.

Let us have a simple, systematic and uniform method of recording surveys and subdivisions and issuing plats and certificates of record that will redound to the credit of American land surveyors, and at the same time be a decided convenience to both surveyors and land owners.

All surveyors who will be likely to need these proposed publications within a year should send at once a postal card to the editor, stating what is desirable in order that he may make a proper estimate of the required number to be published in the first edition.

The probable cost in good substantial binding will be from $8 to $10 per record book of four to six hundred pages; printed blank plats and certificates of record will cost from three to four dollars per hundred by mail; i. e., of the size mentioned. Should another size be adopted the prices may vary accordingly.

Now in the dull season for many surveyors is the proper time to attend to this very important business.

Very Respectfully,
J. M., County surveyor.

Civil Engineers' Club of the Northwest.

NOTICE!

Chicago, Jan. 6, 1876.

Members of this Club are hereby requested **NOT** to send any money to me for Club purposes till further notice.

L. P. MOREHOUSE,
Secretary.

CIVIL ENGINEERS' CLUB

OF THE

NORTHWEST.

No. 57.—BELT RAILROAD PROJECTS IN CHICAGO.

A Paper read before the Civil Engineers' Club of the Northwest by F. W. CLARKE.

During the few years past, the number of roads terminating in this city has been considerably augmented, and a large addition to our through and local traffic is the result. The plan of shipping by what are termed "through freight lines" is now generally adopted. A large part of the tonnage of all new railways is contained in cars which are not opened until they have traveled the length of two or three different roads. This renders necessary the transfer of these cars from the track of one company to that of another. There are over thirteen of these through freight lines now represented here, and the business of transferring their cars has assumed a magnitude measured by an expenditure of hundreds of thousands of dollars.

All this switching is now done over connecting links in the heart of the city, and the roads and sidings are often blocked with cars awaiting an opportunity for transfer. From two days to a week is the frequent delay, before the car is forwarded to its destination. The cost amounts in many instances to $5.00 per car. Each railway has from three to ten engines engaged in the work, which the widely separated yards and limited track facilities make slow and uncertain.

Injury to cars, owing to crowded tracks, crossing bridges, and constant switching, causes considerable loss. Cars are often placed on side-tracks of foreign roads. No report being made of their constant changes on these sidings, they are kept an unreasonably long time. As cars, during the busy season, earn $10.00 per day on a home line, such loss of time is direct to the owner and should be noted in the estimate. Increased traffic demonstrates the inconvenience of present methods of transfer. It was thought a Belt Railway would afford the desired relief, thus reducing the cost and enabling the transfer to be more quickly made. A line of railway was projected from a point near the government harbor at South Chicago, extending completely around the corporate limits, thereby intersecting every railroad that now, or may hereafter enter the city. At each intersection the transfer company intended to provide ample sidings for the reception of cars designed for other roads, and the delivery of cars received from other roads. These sidings to give easy access to incoming and outgoing trains, to have a sufficient number of engines to make a daily transfer of all the arriving through cars, as well as of all cars loading or unloading at lumber yards, or on other side tracks, and at a cost below the present expenditure, and in a manner and time possible under no other system.

Such a scheme is not untried. London and Paris have similar plans in operation while in the United States, Boston has a Marginal freight R. R., and Indianapolis her belt railway.

The first Chicago Belt R. R. of which we have any knowledge was incorporated August, 1873, under the name of the Chicago Transfer Railway and Clearing House Co., and it is with this we have been the most intimately connected. Another company soon after entered the field accomplishing nothing in the way of construction. Later, three other charters were granted, having this same scheme in view; in all, five franchises to surround Chicago with an iron girdle.

The project at its inception received the approval of leading railroad men of the city, and could their co-operation have been secured the scheme would doubtless have been nearer completion than to-day. The mistake was made of not thus enlisting them, and this, together with the hard times of the past three years, led to the suspension of the project. For its accomplishment a stock company was formed with a capital of half a million of dollars.

Immediately upon organization, surveys were made. The route as laid, had for its initial point the Harbor at South Chicago, which would be a feeder to the road by its lumber and manufacturing interests. Advantage was taken of a road already built westward to the Chicago, Rock Island and Pacific R. R., from which track the road bed was graded by the Transfer company to the Pittsburgh, Cincinnati and St. Louis R. R., one and a fourth miles further west. From this point the line ran six miles in a northwesterly direction, and thence north on a line passing three-fourths of a mile west of the city limits, to the Chicago and Pacific R. R. This was designed as a temporary terminus, making a length of about sixteen and one-half miles to be constructed by the company. This, together with the five miles owned by the Rock Island company from their track to South Chicago, made the length of the road 21½ miles. An extension to the Chicago and Northwestern, and Milwaukee and St. Paul crossings would add three and one half miles, making twenty-five miles, the total length when complete. Of this only the grading of 1¼ miles has been accomplished between the Rock Island, and Pittsburgh, Cincinnati and St. Louis railroads. A fair disposition was manifested regarding the right of way, a large part of which could be relied upon as a donation.

The estimated cost of constructing sixteeen and three-tenths miles upon the line indicated. was $506,400 for double track, and $251,600 for single track, including two bridges of of 120 and 160 feet span respectively; the road to be first class in every respect. These figures were made two years ago, and will vary somewhat from present cost. For some time a single track would accommodate the traffic, as the sidings and turnouts would not average one and a half miles apart.

In order to make a fair comparison of the present and proposed methods of conducting the transfers of cars, let us for example take the cars on an incoming train of the Michigan Central railroad destined for the west via the Chicago and Northwestern railway. Passing the proposed crossing of the Belt railroad the train enters the city, proceeding to the Michigan Central freight yards near the river. There, yard engine we will designate no. 1 sorts the train; switching engine no. 2 takes the cars bound for the west, across the main avenues and river to the South Branch yards, where engine no. 3 meets and takes them to the Northwestern yards: there they are sorted and the train made up by yard engine no. 4, and are ready to start upon their through trip. The time taken in the transfer is from twelve to seventy-two hours.

In like manner take the method as proposed by the Belt plan. All cars other than local freight are left on a Y of the Belt railroad. Within two hours they are coupled to a passing transfer train which drops cars at their various points of destination reaching the Northwestern road at a point near Irving Park in three hours, where they are left on a convenient Y; a telegram is sent to the train-master informing him of the number and destination of cars in waiting and the next outgoing freight train comes prepared to take them. The time of transfer ought not to exceed six hours. In the case in hand, the latter method saves over the first plan, three miles switching in a crowded part of the city, not estimating possible damage to cars by the necessary hauling to and fro.

The practicability of a Belt railroad is not generally doubted; a few figures are subjoined, however, which will show in part the feasibility of the scheme. It was with some difficulty that even limited data were obtained. From some roads none were to be had, while others kept no such separate system of switching accounts as would give definite information. Take three representative roads—the Chicago, Burlington and Quincy, the Illinois Central, and the Chicago and Pacific railroads, and from their various accounts select only such items as are applicable to a Belt railroad.

These three roads give a total of 32,800 cars per year transferred by or for foreign roads at an expense in cost and charges of $120,800, an average of $3.68 per car. Included in this average are rates varying from $1.50 to $6.00 per car. Leave out of our calculations the three lines of the Chicago and Northwestern company, and the two lines (the Pittsburgh, Cincinnati and St. Louis and the Pittsburgh and Fort Wayne railroads) of the Pittsburgh, Fort Wayne and Chicago road, as these lines can better ignore a Belt railway than the remaining roads. We have left ten main lines. Of these, offset the Chicago, Danville and Vincennes railroad in the southwestern quadrant of roads entering the city. against the Chicago and Pacific road in the northwestern quadrant, calling the probable quota of each 4,000 cars per year. There are left eight principal roads, two of which have been found to transfer a total of 28,800 cars per year. This number can safely be multiplied by four giving the total of the group of eight roads, which, together with the two roads first considered gives a total of 123,200 cars per year or 338 per day. At the average rate of $3.68 per car the expense of transferring the 123,200 cars amounts to $453,376 per year. It must be borne in mind that only the switching expenses of such cars as could be transferred by the Belt railroad are now considered.

Supposing twenty miles of road to be built by the Transfer company, and the five miles leased of the Rock Island company, we have a total of twenty-five miles representing a capital of $500,000. For the amount of business estimated the annual expense account would be as follows:

Running expenses of engines	$25,000
At each of the thirteen crossings three men and a telegraph operator	38,000
Maintenance and repairs	20,000
Salaries and other expenses	27,000
	$110,000

Assuming an average rate to be fixed at two dollars per car, the 123,200 cars give an annual income of $246,400. Deducting the expenses, as estimated at $110,000 per annum, there is left a balance of $136,400 to provide for interest and dividends.

In conclusion, the following advantages can safely be enumerated as arising from the construction of a Belt road.

1. Greater rapidity in transfer: a saving of one-half the time now consumed.
2. Less expense.
3. Relief to street crossings and crowded tracks in the city.
4. Vacating much valuable property now used as yards which could be turned to some more profitable purpose.
5. Less mileage and damage to cars in switching.
6. Less loss and delay of cars on foreign tracks.
7. Improvement of lands outside the city by offering to manufactories the advantages of competing rates, access to all trunk lines and to one of the best harbors on the lakes.

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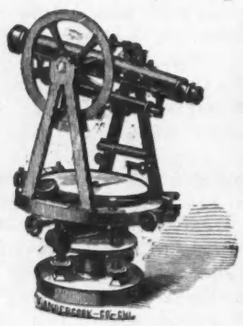

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